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PATENT APPLICATION

DEVICE DRIVER SYSTEM

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DEVICE DRIVER SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

- This application is a continuation of International Application Number
- 5 PCT/GB02/05233, with an international filing date of November 20, 2002, and
designating the United States and which in turn claims priority to UK application No.
01227865.4, filed on November 21, 2001.

BACKGROUND OF THE INVENTION

1. Field of the Invention

- 10 This invention relates to systems for driving computer peripherals that have
features which are not envisaged by the generic operating system for the computer, and it
relates especially, though not exclusively, to the implementation of 3D sound capability
via Universal Serial Bus (USB) audio hardware.

2. Description of the Related Art

- 15 The Microsoft Windows family of operating systems is currently widespread and
dominant in the computer market and hence all audio-related peripheral devices, such as
sound cards and loudspeakers, are built to comply with a suitable Windows interface.
However there are certain features, such as 3D positioning of sounds and environmental
effects, that are not specifically catered for by the system provider and for which there is
20 thus no driver capability.

Windows provides well-defined interfaces between the operating system and drivers for envisaged devices; the interface in each case being defined by a Windows Driver Model (WDM). The WDM specification covers drivers for all envisaged devices and there are detailed sections of the specification that relate to a range of device classes, such as printers, graphics and audio devices. These more detailed sections specify the content and form of the information that must flow through the WDM interface in order to achieve the envisaged functionality of the respective device classes.

Unfortunately, there is no simple way of enabling the system to perform functionalities that have not been incorporated into the drivers by the provider of the operating system.

Figure 1 of the accompanying drawings illustrates schematically the relationship between an operating system 1, a WDM audio driver 3 and a hardware device 5; the system 1 being linked to the driver 3 by means of a WDM interface 2 and the driver 3 being linked to the hardware 5 by means of an interface 4.

The WDM interface 2 dictates that all communication between the operating system 1 and the device driver 3 is conveyed as Input/Output Request Packets (IRPs); these being memory data structures of predefined format that are initialized with data pertaining to a required operation. IRPs can carry information both from and to the driver 3 as well as an instruction to perform a function and, for every required operation, the operating system creates one or more IRPs that are sent to the device driver. The device

driver is then required to respond in a prescribed manner, according to the WDM specification.

If it is desired to employ, in such an environment, a hardware application for which the device driver is not configured, such as that required to achieve 3D sound capability, then the functionality of the device driver needs to be altered and/or augmented. However the two most direct methods available for putting such alteration and/or augmentation into effect both have significant drawbacks associated with them.

In order, for example, to modify the source code for the driver, one naturally needs to have access to the source code. That for Microsoft's USB audio driver is not available for alteration and, even if it were, there would be concerns about the alterations creating unexpected ramifications in other areas of the functionality.

If, on the other hand, one were to incorporate a WDM filter driver, allowing modifications to be made to the stream of IRPs flowing between the operating system and the driver, different problems could arise. In particular, because the IRP data structure is designed to implement generic communications between the operating system and the device driver of a generic device, the IRPs transmitted do not always map simply on to the complex operations being requested. Thus it is often impractical to augment the existing functionality of the base device in this way because there are insufficient features upon which to build.

The invention aims to provide a device driver system which can enable, without incurring the drawbacks referred to above, the implementation of functionalities not catered for by the provider of the operating system.

SUMMARY OF THE INVENTION

To achieve the foregoing, the present invention provides a device driver system. According to the invention there is provided, in a software-implemented arrangement for
5 driving at least one hardware device of predetermined functionality from an operating system that communicates with an installed driver for said hardware device, a device driving system enabling operation of at least one further hardware device of functionality differing from said predetermined functionality and unsupported by said software system; the device driving system including additional driver means interposed between the
10 operating system and the said installed driver and configured to interface directly with at least said operating system.

Preferably, the additional driver means is also configured to interface directly with said installed driver, thereby enabling continued and unchanged use of said at least one hardware device of predetermined functionality.

15 In a further preferred arrangement, the said additional driver means is additionally configured to interface with, a further driver which is configured to drive an additional hardware device. This permits the original at least one hardware device to continue in use in conjunction with the additional hardware device.

Preferably said hardware devices are audio devices and in particular the original at
20 least one device comprises USB audio hardware and the additional device comprises hardware associated with 3D positioning of sounds or environmental effects.

In one preferred embodiment the operating system is the Windows operating system and the said installed driver comprises a Windows Driver Model (WDM) audio driver.

These and other features and advantages of the present invention are described
5 below with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 of the accompanying drawings illustrates schematically the relationship between an operating system 1, a WDM audio driver 3 and a hardware device 5.

Figure 2 shows, in schematic form similar to that of Figure 1, a device driver
5 system in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference will now be made in detail to preferred embodiments of the invention.

Examples of the preferred embodiments are illustrated in the accompanying drawings.

While the invention will be described in conjunction with these preferred embodiments, it

5 will be understood that it is not intended to limit the invention to such preferred
embodiments. On the contrary, it is intended to cover alternatives, modifications, and
equivalents as may be included within the spirit and scope of the invention as defined by
the appended claims. In the following description, numerous specific details are set forth
in order to provide a thorough understanding of the present invention. The present
10 invention may be practiced without some or all of these specific details. In other
instances, well known process operations have not been described in detail in order not to
unnecessarily obscure the present invention.

According to the invention there is provided, in a software-implemented
arrangement for driving at least one hardware device of predetermined functionality from
15 an operating system that communicates with an installed driver for said hardware device,
a device driving system enabling operation of at least one further hardware device of
functionality differing from said predetermined functionality and unsupported by said
software system; the device driving system including additional driver means interposed
between the operating system and the said installed driver and configured to interface
20 directly with at least said operating system.

Preferably, the additional driver means is also configured to interface directly with said installed driver, thereby enabling continued and unchanged use of said at least one hardware device of predetermined functionality.

In a further preferred arrangement, the said additional driver means is additionally
5 configured to interface with, a further driver which is configured to drive an additional hardware device. This permits the original at least one hardware device to continue in use in conjunction with the additional hardware device.

Preferably said hardware devices are audio devices and in particular the original at least one device comprises USB audio hardware and the additional device comprises
10 hardware associated with 3D positioning of sounds or environmental effects.

In one preferred embodiment the operating system is the Windows operating system and the said installed driver comprises a Windows Driver Model (WDM) audio driver. This invention thus provides, under the control of a specific operating system, for the operation of hardware envisaged by the provider of the system and additional
15 hardware not envisaged by the system provider, and is thus distinguished from systems, such as that described in EP-A-0 798 637, for adapting an application program to communicate with a device driver in a different operating environment or device driver systems, such as that described in EP-A-0 506 278, intended to be generic to a plurality of different operating systems.

In order that the invention may be clearly understood and readily carried into effect, one embodiment thereof will now be described, by way of example only, with reference to the accompanying drawings, of which:

Figure 1 has already been referred to and Figure 2 shows, in schematic form
5 similar to that of Figure 1, a device driver system in accordance with one embodiment of the present invention. With reference back to Figure 1, it will be recalled that the driver 3 which, in this example, is a WDM audio driver, is disposed intermediate the windows operating system 1 and the USB audio hardware 5. The audio driver 3 can be conceptually regarded as comprising three entities respectively performing the following
10 functions:

(a) managing the interface between the operating system 1 and the driver 3, in particular with regard to processing and responding to IRPs;

(b) processing the data fed into the driver 3 and

(c) managing the hardware device, such as by writing control values into
15 registers.

The present invention is concerned, as has been stated, with permitting the usage of hardware devices which are not catered for by the operating system 1, without adversely affecting the functionality of hardware devices originally supported by the operating system 1, and one way of implementing the invention will now be described
20 with reference to Figure 2.

In Figure 2, components and functions common to Figure 1 carry the same reference numbers, and it will be seen that there is essentially provided a new device driver 6. The driver 6 is interposed between the operating system 1 and the WDM driver 3, and replicates the interface 2 at its interfaces with both.

5 The new driver 6 resembles driver 3 and its three functional entities are arranged to perform the following functions:

(a) responding to IRPs from the system 1 in the correct manner, offering all required functionality;

(b) performing all necessary processing of the data in order to provide the
10 required functionality; and

(c) communicating with the driver 3 using the same IRP structures that the operating system 1 would normally use.

Since the new driver 6 communicates directly with the operating system 1, it is able to offer any required features. The original manufacturer's driver 3 is communicated
15 with from the new driver 6 in a manner which is indistinguishable from direct communication with the operating system, and it therefore functions normally, with the audio being produced by the hardware 5, thus the hardware which it drives can comprise the original device 5 or a new and previously unsupported device such as a 3D sound system.

In the event that it is desired to maintain drive control over existing audio devices whilst further providing drive for a new device, the device driver 6 can be provided with one or more additional WDM interfaces, as shown in Figure 2; all of such additional interfaces being identical to the interface 2. This permits the operation of optional
5 additional hardware devices such as 9 by way of additional WDM audio drivers such as 7 operating over respective interfaces such as 8.

The approach described herein of utilizing a new driver such as 6 with which the operating system 1 communicates directly, offers a number of advantageous features, as follows:

- 10 1) existing audio device drivers remain in use, thereby making optimum use of available drivers without alteration. Retrofitting to any WDM compliant audio device is thus facilitated;
- 2) The implementation of the WDM specification by the new driver (6) is indistinguishable from that of a standard device driver, thus no alterations are required
15 either to the operating system or the applications executed under it;
- 3) The WDM specification is implemented on all recent versions of the Microsoft Windows family of operating systems and thus it is possible to use the same approach and, indeed, the same device driver, on all such versions; and
- 4) extended functionality can be offered by using multiple input and output
20 devices.

Although the foregoing invention has been described in some detail for purposes of clarity of understanding, it will be apparent that certain changes and modifications may be practiced within the scope of the appended claims. Accordingly, the present embodiments are to be considered as illustrative and not restrictive, and the invention is
5 not to be limited to the details given herein, but may be modified within the scope and equivalents of the appended claims.